evaluate energy savings EU

Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services

Selected case studies on top-down methods

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January 2008

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coordinated by

Wuppertal Institute for Climate, Environment and Energy

funded by

Intelligent Energy Europe

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Introduction to case studies

- In top-down methods, **energy savings** are calculated from statistical indicators
- **Three main types of indicators or methods can be considered:**
  1. TD1:Market diffusion of energy efficient technology (e.g. share of public transport of goods or passenger, of solar water heater, of cogeneration in industry) ➔ total energy savings calculated from increase in market share
  2. TD2a: Specific energy consumption of a well identified equipment (e.g. cars, refrigerators➔ total energy savings calculated from reduction in specific energy consumption of the equipment (l/100 km, kWh/appliance)
  3. TD2b: Unit energy consumption of a sub-sector (e.g. thermal uses and electricity uses in household, industry or services ➔ total energy savings calculated from change in the unit energy consumption trend of the sub-sector
- Three case studies corresponding to each of the 3 types of indicators:
  - ✓ New cars
  - ✓ Modal shift
  - ✓ Electricity uses in the service sector

New cars

Relevant variables to estimate energy savings for new cars

➢Indicators used to measure energy savings: change in the test specific consumption of new cars sold every year in litres/100km

➢change in the test specific consumption of new cars can be explained by the following factors/variables :

- Change in the average size of vehicles (in terms of weight, or horse power or engine size in cm3) (“hidden structure effect”) (if trends towards larger or more powerful cars ➔ energy savings are underestimated)
- Autonomous trend (in technical efficiency)
- Motor fuel price
- EU policy (ACEA/JAMA/KAMA agreement) and national energy policy measures (tax on motor fuels, subsidies/ tax on vehicles): after 1995/ before 1995

➔Effect of change in the size of vehicles interesting to consider but limited in practice due to data availability ; only tested for one or two countries; indicator of energy saving used: litres/100km/kW (or in litres/100km/Cm3)

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Necessary data for new cars: possible sources

➢ **Data on the specific consumption of new cars (test value):**

- ✓ annual monitoring of the ACEA/JAMA/KAMA agreement for **all EU-15** countries **since 1995** ; **not available for new EU members**.
- ✓ for a few countries, available as **long time series** since the 80's with a break due to a change in the way to measure the test consumption
- ✓ Data by car size available for a few countries from national sources (e.g. France, Ireland); from international sources, only available for ACEA, which represent a decreasing market share of cars sales in the EU

➢ **Annual distance driven by new cars:** only available for the total stock ➔ underestimation of energy savings as new cars travel more than the stock average

➢ **Technical coefficient accounting for the difference between the test value and the actual value for the specific consumption**: to be calibrated from actual data available (e.g. estimated in a range of 15-20% from Secodip survey in France) and/ or by comparison between the simulated gasoline or diesel consumption of cars and the actual gasoline or diesel consumption of cars.

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Selection of variables to model energy savings for new cars

➢ Modelling of the specific consumption of new gasoline and diesel cars separately* (SC) (in litre/100km/cm^3* or litre/100km), with two variables :

- Time to capture an autonomous trend
- Average price of gasoline and diesel

$$Ln(SC) = T \times ln(t) + A \times ln(P) + K$$

- ✓ SC: specific consumption of new cars in litre/100km/cm^3 or in litre/100km/kW
- ✓ T: trend
- ✓ A: price elasticity (<0)
- ✓ P: motor fuel price

➢ The energy savings associated to price changes will then be split into two components: energy savings linked to tax increase (policy related) and savings linked to change in crude oil price (market related)

➢ Two key questions

- What autonomous trend to be considered ?
- Are motor fuel prices econometrically significant ?

* To clean the effect of fuels substitution between gasoline and diesel on the average specific consumption

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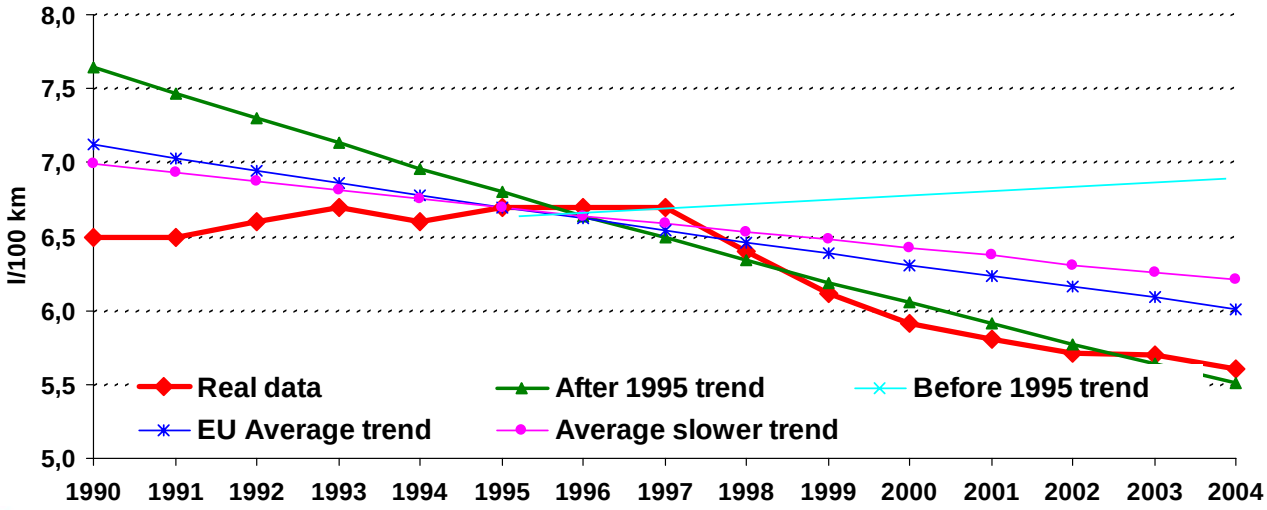
Econometric analysis

Which autonomous trends to be considered as baseline?

- **Trend before 1995** (ie before the ACEA/JAMA/KAMA agreement) **("before 1995 trend")**
- **Trend since 1995 ("after 1995 trend")** ➔ **reference used in the following case studies**
- **EU average trend =** > -1.1%/year for diesel
- **Trend of the average of the 3 countries with the lowest autonomous trend ("average slower trend")**

Specific consumption of new diesel cars (France)



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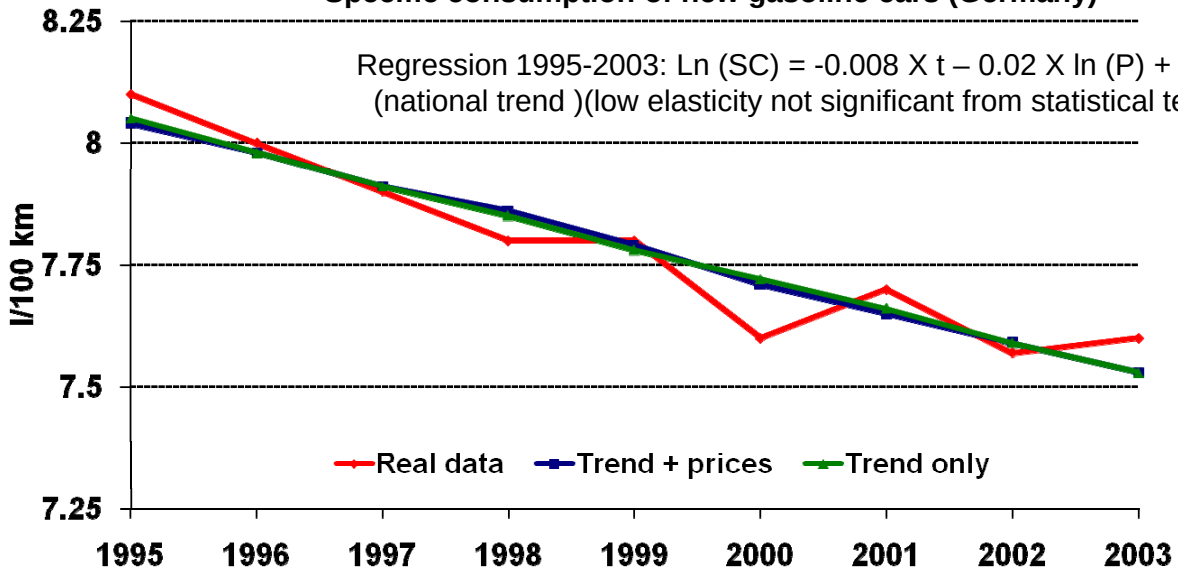
Econometric analysis

Are motor fuel prices econometrically significant?

Prices elasticity not significant for most countries : often positive value or value not validated by statistical test:

- too short period
- price not changing so much over the period of regression;

Specific consumption of new gasoline cars (Germany)



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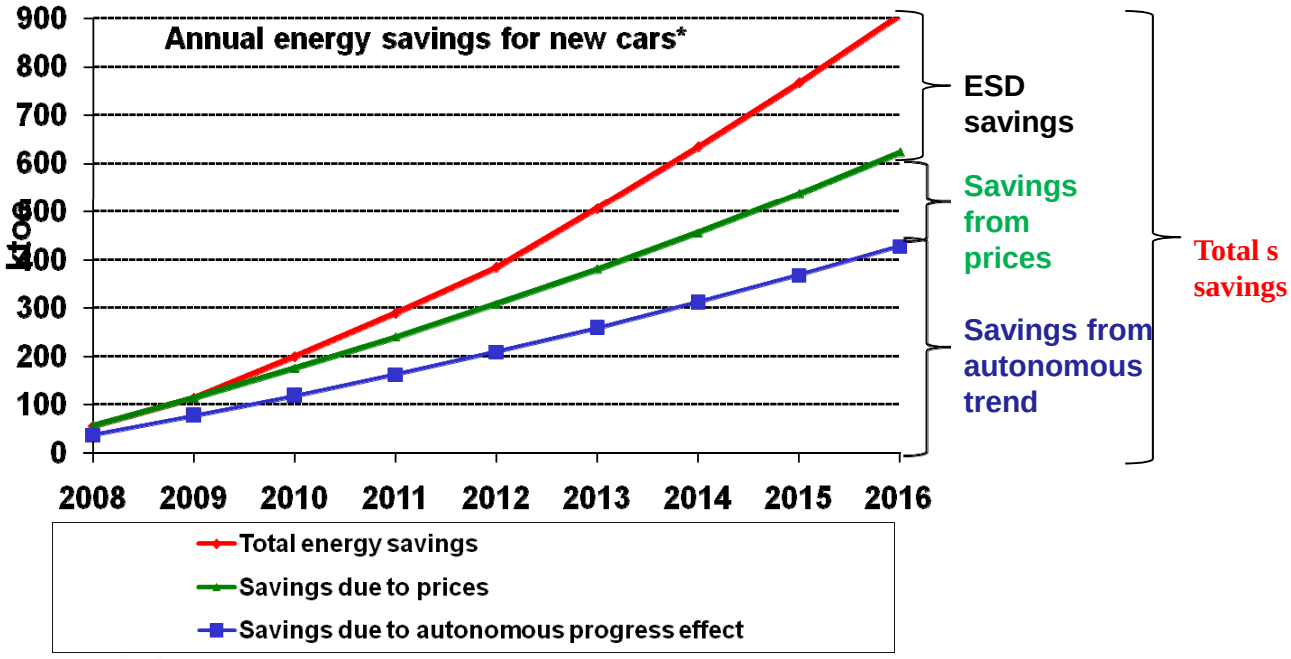
Calculation of ESD savings: example

ESD energy savings (about 400 **ktoe/year in 2016):** difference between total energy savings (about **1000 ktoe/year)** and energy savings induced by autonomous trend and price effect **(**-0.8%/year autonomous trend and price elasticity of -0.25)



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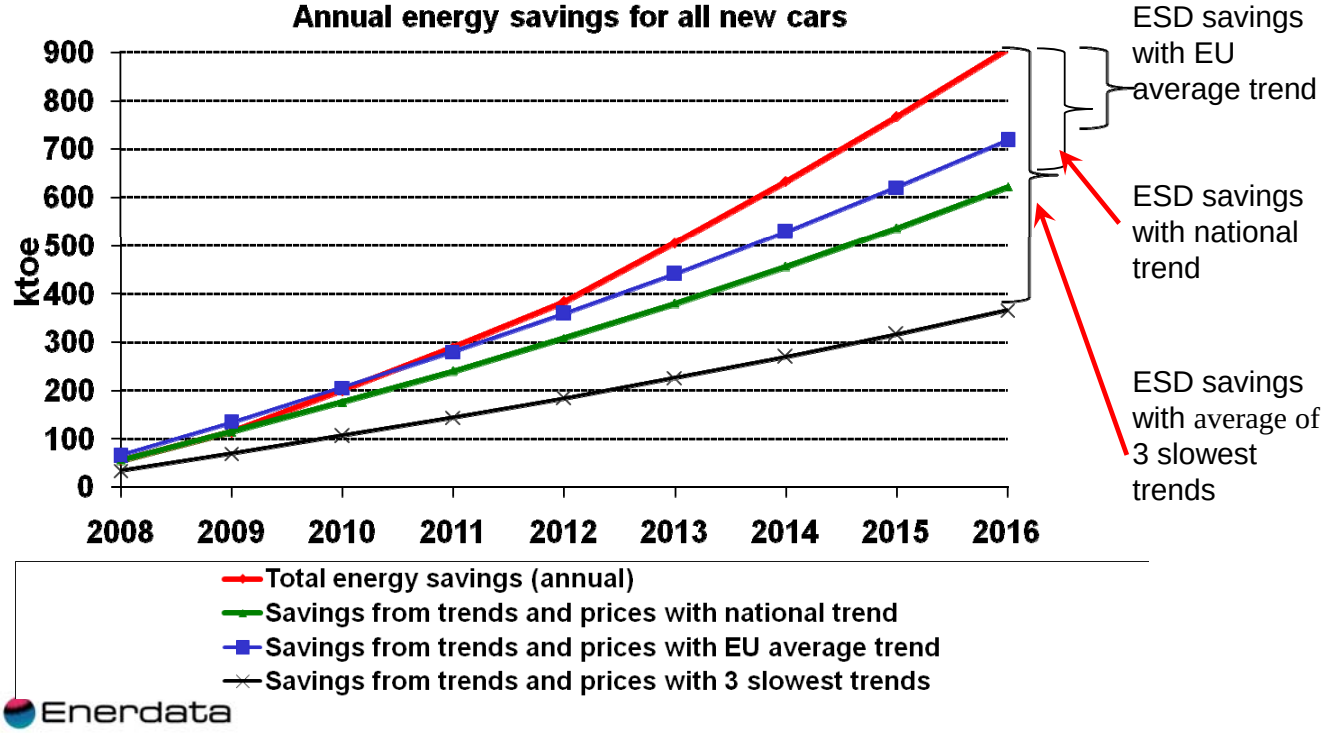
Calculation of ESD savings: sensitivity study on trend

If baseline is EU average trend instead of national trend ➔ESD savings divided by 2
If baseline is average of 3 slowest trends ➔ESD savings multiplied by 2
This of course depends on the actual country's trend



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Modal shift for transport of goods

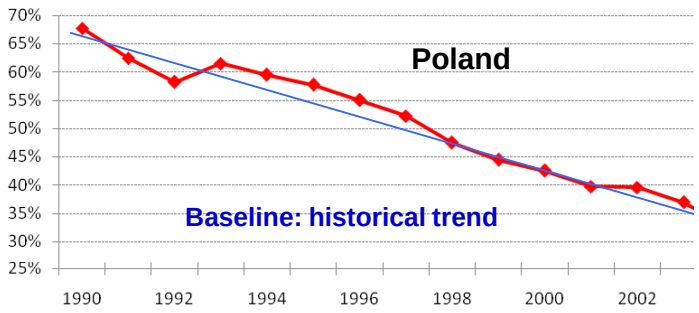
Top-down estimation of energy savings for modal shift

- Indicator used to measure energy savings: share of rail and water (non road transport).
- Change in modal shift can be generally explained by the following variables:
  - Autonomous trend
  - Cost difference by mode

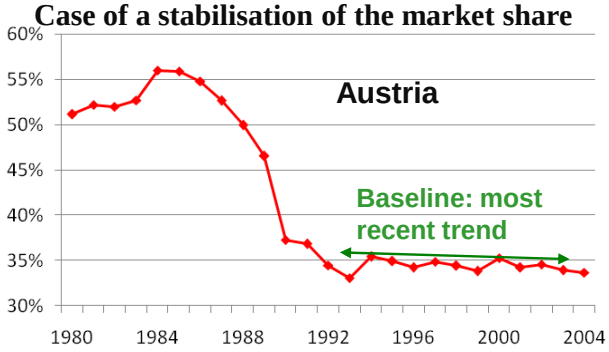
  } **Defines the baseline**
  - Facilitating measures to promote modal shift (After / before 1995)
  - Other transport measures (relative investment in road/rail/water infrastructure)
- In practice, taking into account the data usually available, modal shift in the absence of policy measures (baseline) can be modelled with two main variables :
  - Time to capture the autonomous trend
  - Average diesel price, as a proxy to measure change in relative costs
- Different situations among EU countries as to the trend in the share of rail and water transport for goods (see following typical cases)

Trends in the market share of rail and water in total traffic of goods (%)

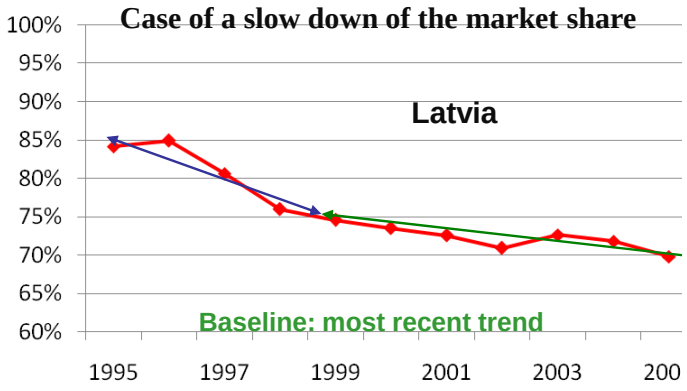
Case of a regular market share reduction



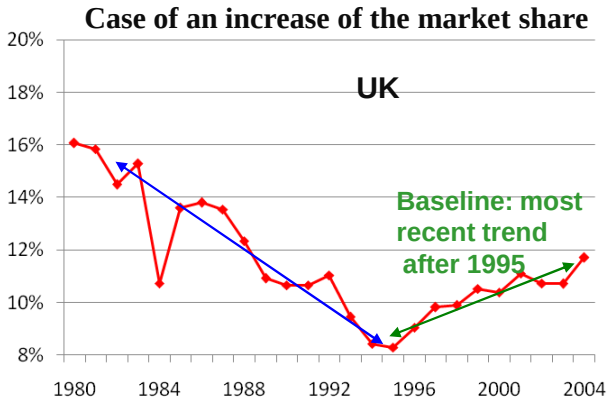
Case of a stabilisation of the market share



Case of a slow down of the market share



Case of an increase of the market share



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Modelling of the baseline modal shift for transport of goods

➢ Modelling of the share of non road traffic through regression analysis with two variables:

- Time to capture an autonomous trend
- Average diesel price used to capture price differential

Ln (WRS) = T X t + A X ln (P) + K

✓ T: trend
✓ A: price elasticity (>0)
✓ P: diesel price

➢Price elasticity calculated from regression not significant for most countries (e.g. <0 despite an important increase of diesel prices)

➢It is proposed to use an exogenous and asymetric price elasticity, with a lag of 3 years to well capture the impact of price :

✓ 0.46 if prices increase (EU average between 2001 and 2005)
✓ and 0 if prices decrease

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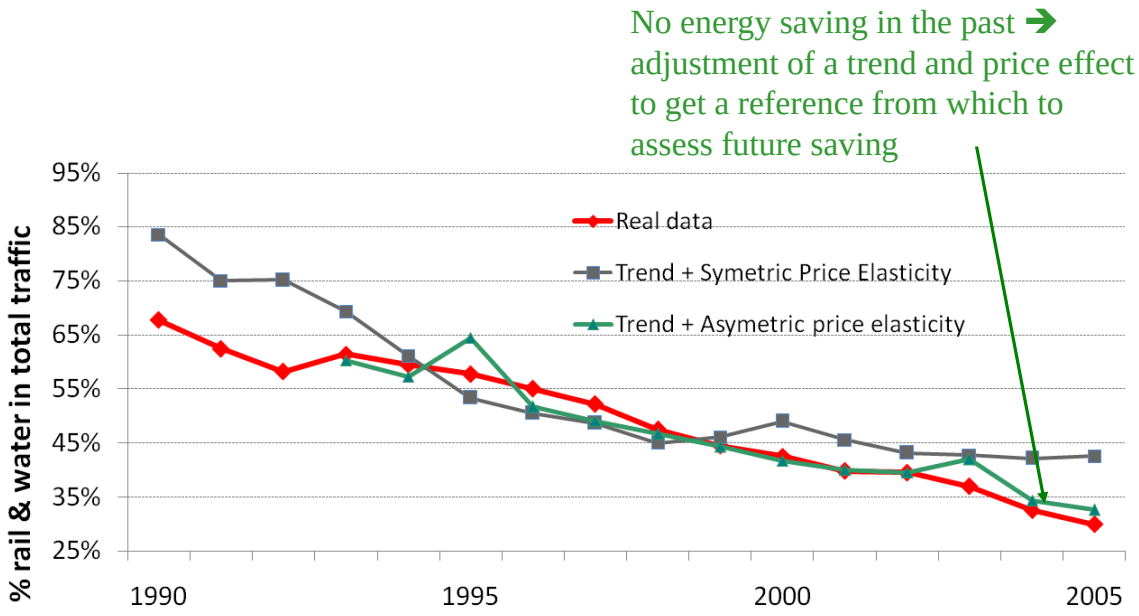
Modelling of baseline modal share Poland

➢ **Asymetric final regression :**

ln (WRS) = -0.05 X t + 0.46 x ln (P_{-3}) + 0.3 if prices increase

ln (WRS) = -0.05 X t - 0.3 if prices decrease



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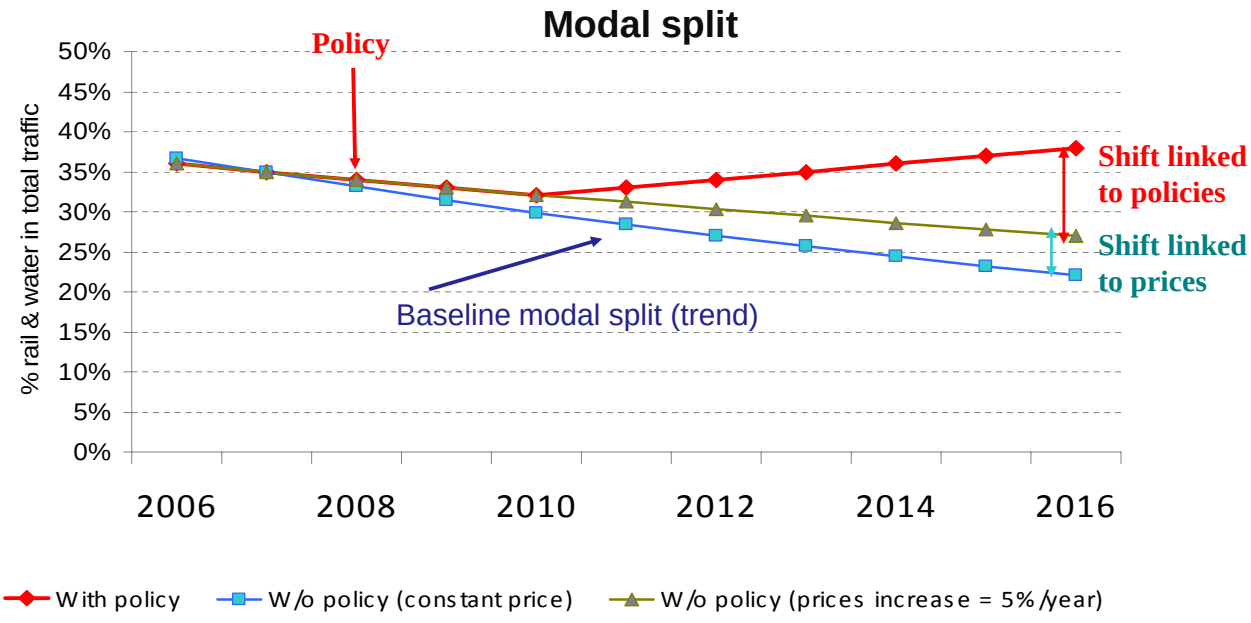
Calculation of ESD energy savings: 1 Calculation of modal split

➢ Assumption of the implementation of a policy in 2008 with first impact in 2010 (rail and water traffic market share assumes to increase by 1% of each year)



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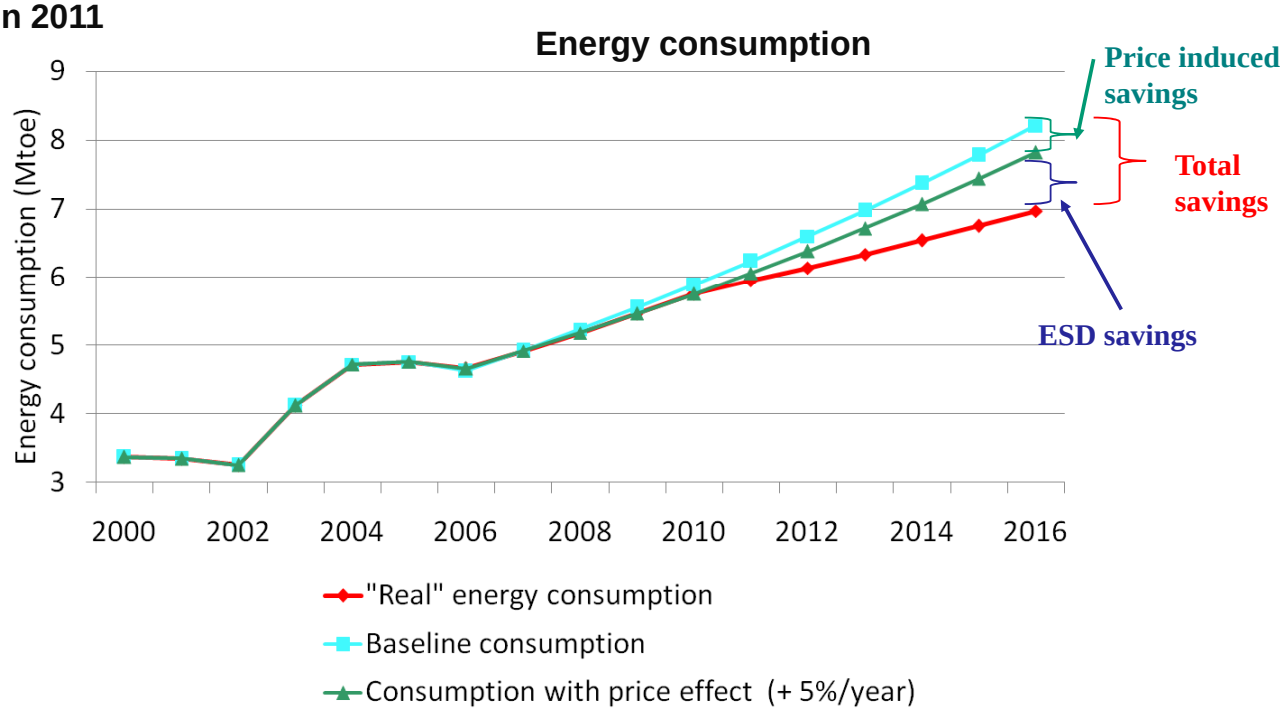
Calculation of ESD energy savings: 2 Calculation of baseline energy consumption and energy savings

➢ **Assumption implementation of a policy in 2008 and first impact of the policy in 2011**



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Electricity end uses in services

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Top-down estimation of energy savings for electricity end uses in services

➢Indicators to measure savings : unit electricity consumption per employee (excluding electricity for thermal uses when data available) measured :

- from the sum of unit electricity consumption by activity branch (detailed approach) to clean the changes in the structure of service sector activities ("hidden structure effect") ➔ the best approach but data available only for few countries
- from the total unit electricity consumption for service sector (aggregative approach) if data by branch are unavailable.

➢Use of unit electricity consumption per employee because

- Physical indicators used and not economical indicators: energy needs related more to work conditions than to production
- Employment data more robust than surface data

➢Change in unit electricity consumption can generally be explained by the following variables:

- Autonomous trend
- Electricity price

} **Defines the baseline**

- Energy efficiency facilitating measures (subsidies, fiscal incentives, VA, taxes) (After / before 1995)

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Modelling of the baseline unit electricity consumption of services

➢ Identification by country of a period over which policy measures either are negligible or have a limited impact ➔ over that period changes in unit electricity consumption mainly linked to autonomous trend, electricity prices

➢ Modelling over that period of the indicator through regression analysis with two variables:

- Time to capture an autonomous trend
- Electricity price

$$Ln(UC) = T \times t + A \times \ln(P) + K$$

- ✓ T: trend
- ✓ A: price elasticity (<0)
- ✓ P: electricity price

➢ The price effect was generally not validated by statistics test as electricity prices did not change enough in the past

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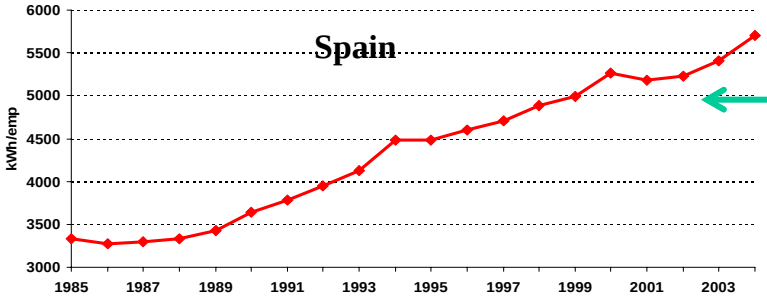
Classification of countries

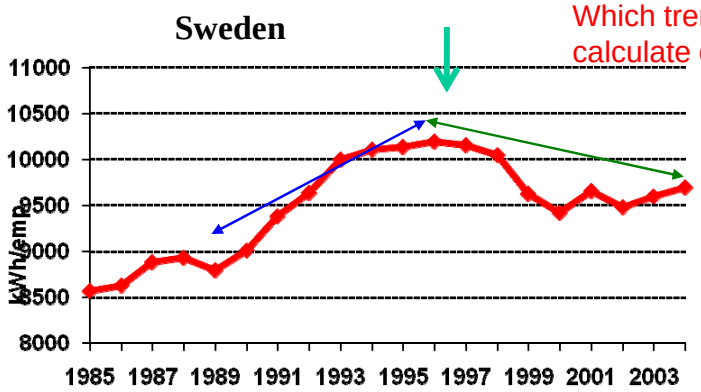
Countries with steady increase of the unit electricity consumption per employee

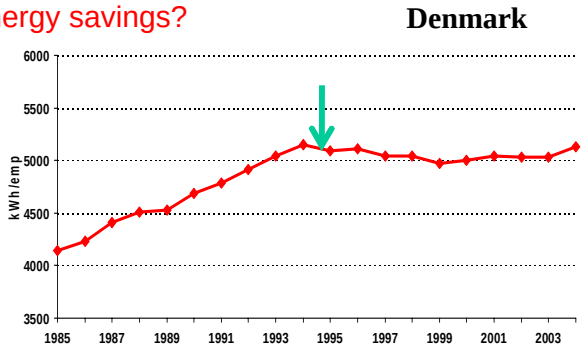


Trend easy to measure. Impact of measures not visible, if any (low impact ➔ any deviation in the future compared to the trend can be linked to measures

Countries with a break in the unit consumption trend (slower increase, stabilisation or decrease)

Which trend to be considered to calculate energy savings?





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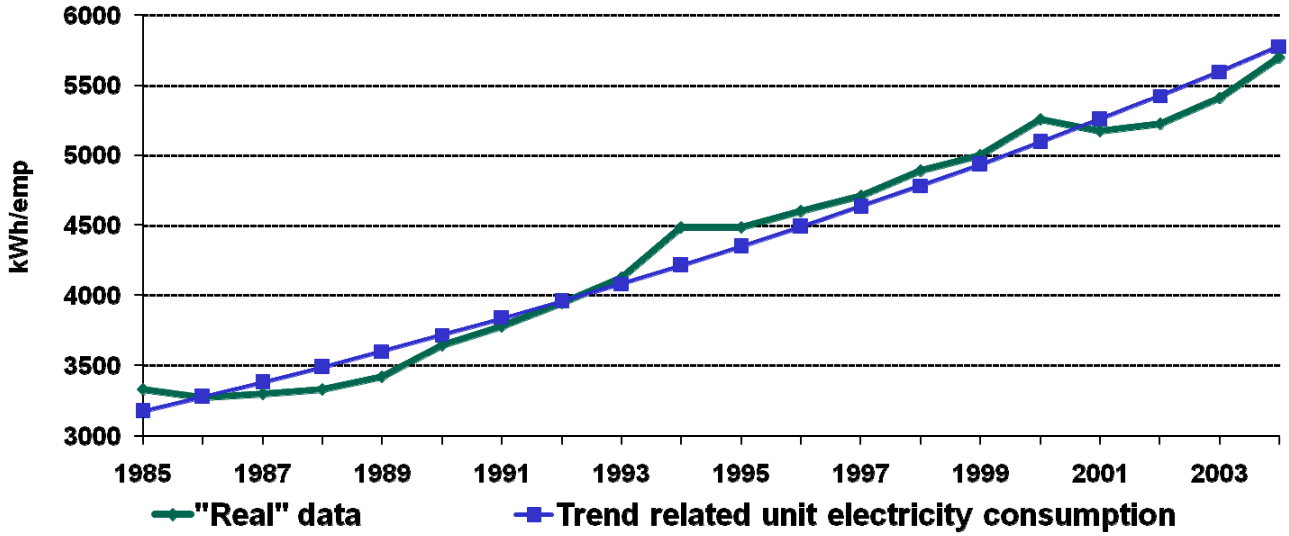
Modelling of the baseline unit electricity consumption of services : case of Spain

- ln (UC) = 0.03 X t + 8.06 (regression over the 1985-2004 period)
- Prices not validated by econometric tests

Unit electricity consumption per employee



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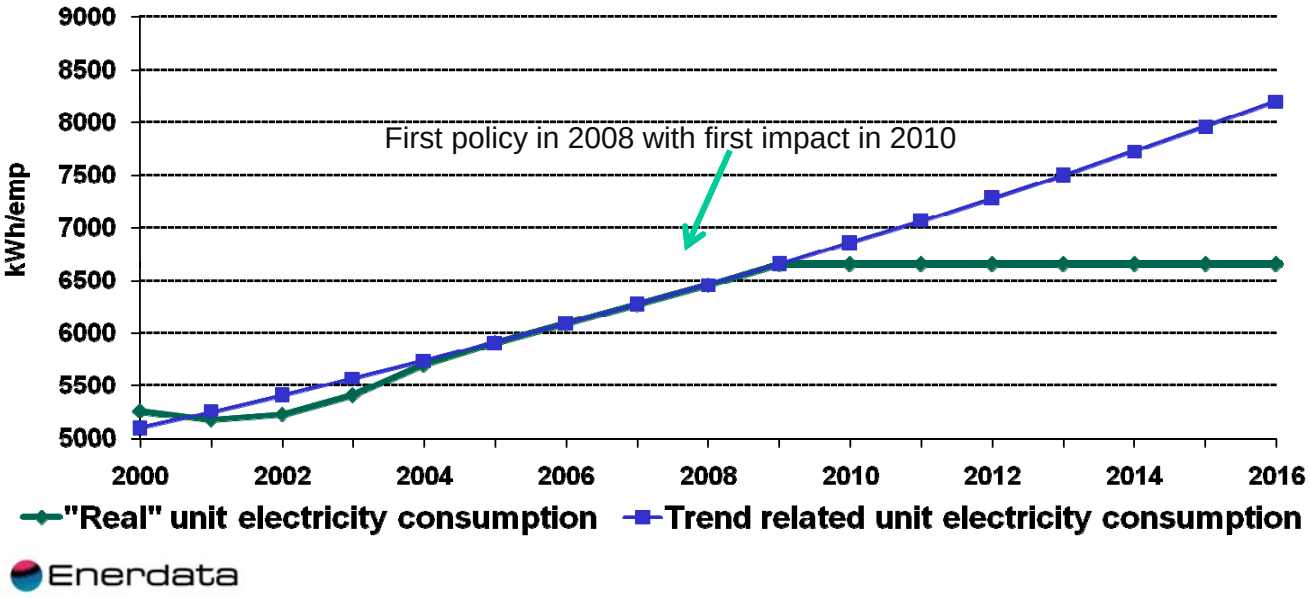
Calculation of ESD savings

1. Calculation of the trend for the electricity consumption per employee

➢**Stage 1 : Calculation of the trend electricity consumption per employee**



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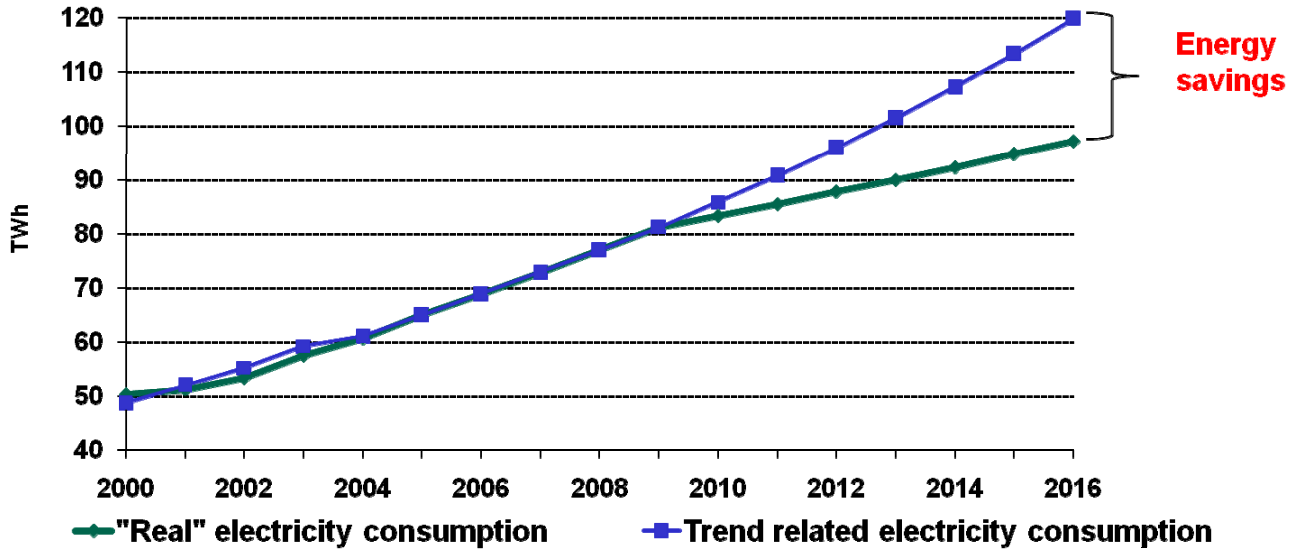
Calculation of ESD savings

➢**2 :** Calculation of the trend related electricity consumption
➢**3 :** ESD energy savings calculated by difference between total electricity consumption and trend related electricity consumption



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Conclusions on case studies : issues that need decisions

Issues that need decisions

Following the case studies, the correction for autonomous trend and price effect has raised three main questions, for which decisions are needed:

1. For the market price correction, i.e. to measure the part of total energy saving that is due to market price increase, how to account for price effect?

2. For the assessment of savings linked to autonomous technological trend (transport modes, electrical appliances), how to define this historical autonomous trend?

3. For the assessment of savings linked to a non-technical trend, which reference trend to use?
   - ✓ Case of thermal uses or electricity uses in household, industry or services
   - ✓ Case of the penetration of an efficient technology (solar, cogeneration) or mode of transport (modal shift)

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1. How to concretely account for price effects: open questions?

- **What value to be used for the price elasticity?**
  - ✓ National data if relevant (in most countries the values obtained from statistical regression have been found non significant)
  - ✓ Or **default values, the same for all countries** (with the objective of harmonsiation)

- **For default values, what value to be used?**
  - ✓ **The EU average if meaningful; if not, expert judgement**
  - ✓ Average of countries with relevant elasticities (could give arbitrary results since it could be based on few and non-representative countries)
  - ✓ Expert judgement

Note: in red, our proposal

Note: the lower the elasticity the lower the correction, and the higher the ESD saving, since we propose asymmetric elasticities (i.e., if prices increase, baseline will be reduced; if prices decrease, no change in baseline); if elasticity is equal to 0, this means no correction for market prices; a low value will be favoured by Member States

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Accounting for price effects: example of new gasoline cars in France

- **National price elasticity**
  - ✓ Equal to -0.10 1995-2005 period
  - ✓ Not validated by econometric tests on the 1995-2004 or 1992-2005 period

- **Default values for elasticities**
  - ✓ EU average price elasticity not meaningful
  - ✓ Average of countries with relevant elasticities : DK=-0.11, ES=-0.14 and FR=-0.10 => about -0.12

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2. Which autonomous technological trend to use for the assessment of savings of vehicles and electrical appliances?

For energy savings, related to an equipment (e.g. refrigerators, cars), the autonomous energy efficiency progress is mainly an autonomous **technological** trend:

- How to define this autonomous **technological** trend ?
  - ✓ A "national trend" (i.e. a different trend for all countries) or,
  - ✓ the **same trend for each country,** as technical progress should be the same in Europe ?

- If the same trend is assumed, what value to be taken?
  - EU average trend (weighted average)
  - **Average arithmetic trend of countries with the slowest trend** (non weighted), as reflecting countries with no effective national policies :
    - ✓ the half of countries below the EU average, or
    - ✓ the 3 countries with the lowest trend?

Note: in red, our proposal

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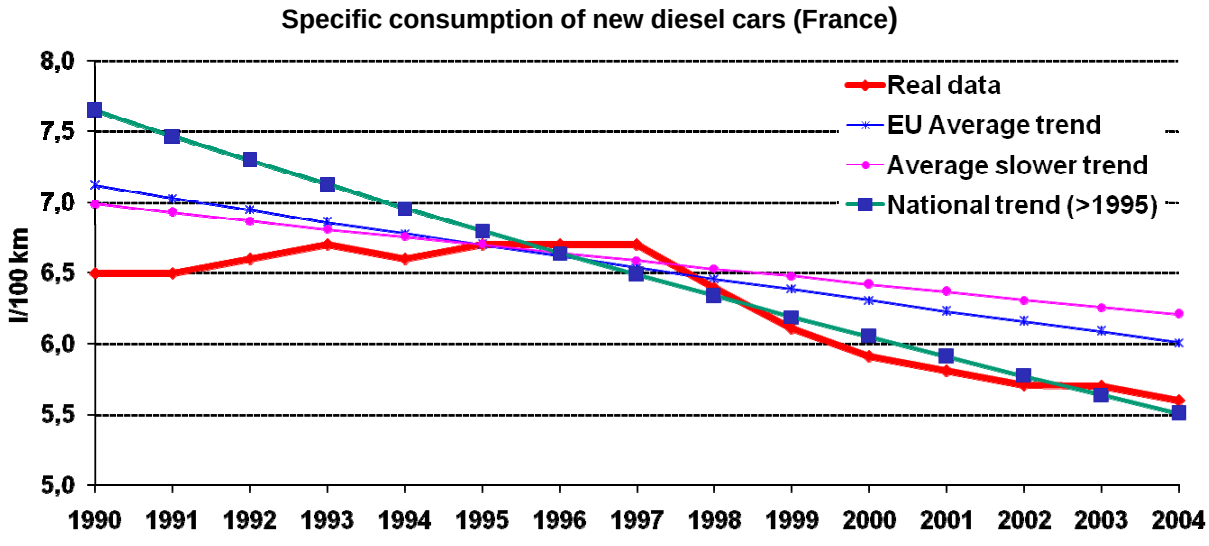
Defining the autonomous technological trend : example of new diesel cars in France

- National trend
- EU average trend = > -1.1%/year for diesel
- Average trend of countries with the lowest autonomous trend ("average slower trend")



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Which reference trend to use for the assessment of savings linked to a non technical trend?

Two options as to which reference trend to take:

➢For end-use with policies (e.g. solar heaters or cogeneration): national trends before policies

…..except for mature markets (e.g. Germany or Austria for solar) ➔ use a default value derived from countries with a same climate

➢For other uses, where there are generally not yet visible policies, and thus measuring energy savings **requires definition of a trend** (case of energy indicators that are increasing, such as for electricity uses, or case of decreasing market share, such as modal shift; but also for indicators that are decreasing, such as for heating fuel consumption): default value calculated as a function of market share (e.g. modal shift) or value of the indicators (e.g. kWh/employee) (calculated from historical data and corresponding analysis)

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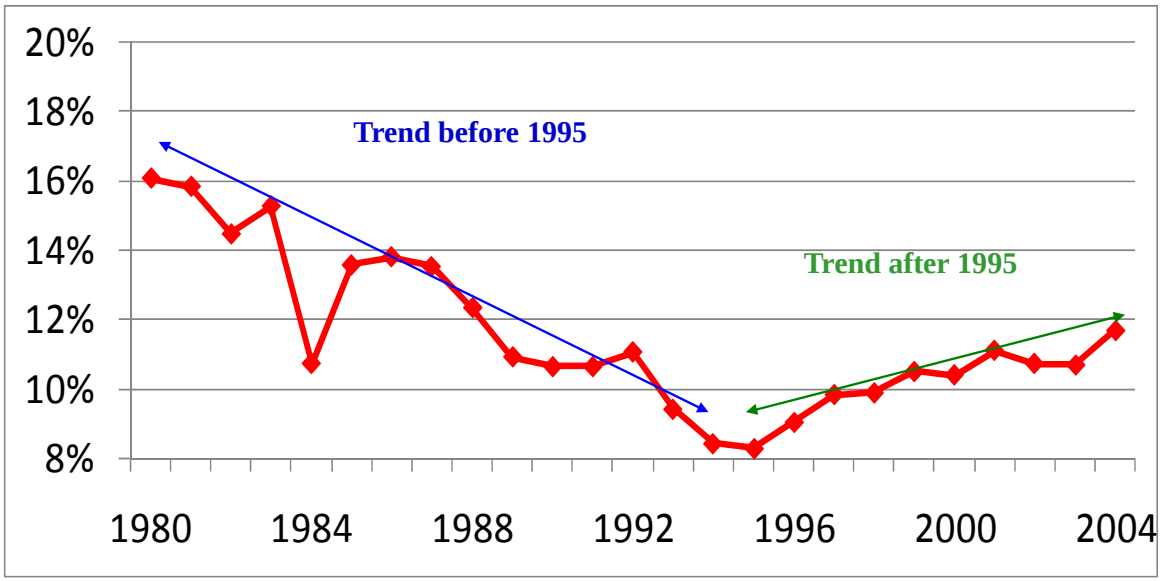
Assessment of savings linked to a non technical trend: case of modal shift

Share of railways and inland waterway in transport of goods (%)



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Assessment of savings linked to a non technical trend: case of mature markets for solar (Germany)

Several policies implemented for solar water heaters (1993, 1995, 1999), plus ecological tax in 1999. Over which period do we do the regression? The diffusion mainly significant since 1999.